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On the Structure of the Skull in the Plesiosaurian Reptilia, and on Two New Species from the Upper Cretaceous.

By E. D. Cope.

(Read before the American Philosophical Society, February 2, 1894.)

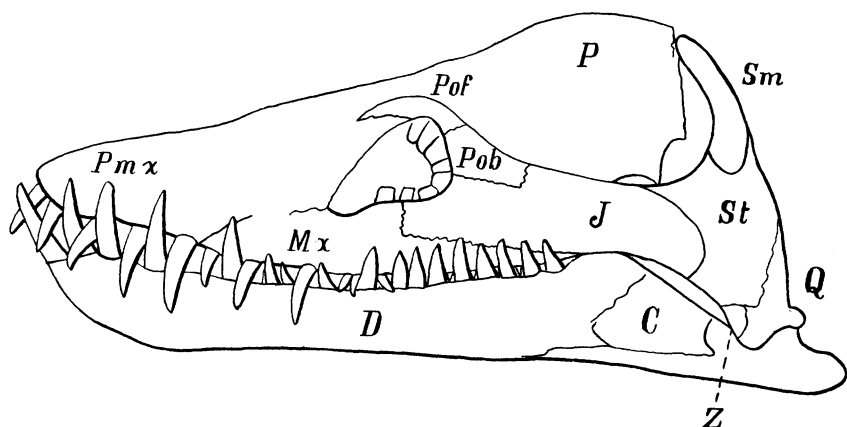
Prof. S. W. Williston has described in the *Proceedings of the Kansas Academy of Science* for 1890, the skull and part of the skeleton of a Plesiosauroid from the Niobrara Cretaceous of Kansas, under the name of *Cimoliasaurus snovi*. Through the kindness of Prof. Williston, I have had the opportunity to examine the specimen, and I have been able to make some observations on the structure of the skull, which supplies an important desideratum in our information on the subject.

In a paper in which I endeavor to trace the homologies of the cranial bars of the Reptilia,* I ascribe † to the Sauropterygia a single postorbital arch, and state that the available evidence is to the effect that this is the zygomatic. I remark, "The supratemporal has no anterior connections according to this author" (Von Meyer on *Nothosaurus*), "and the supramastoid is not described. From all that I can gather from Owen's figures and descriptions of *Plesiosaurus*, the structure is the same, which is confirmed by observation on such imperfect specimens as are accessible to me."

Examination of Williston's specimen shows that there is but one postorbital bar, and that this is partly the zygomatic, since it extends to the distal extremity of the quadrate, and encloses with it a small zygomatic or quadratojugal bone. But the posterior part of the arch includes also a large supratemporal, as in many *Testudinata*. Above the supratemporal, and forming the parietomastoid arch, is the separate element which I have referred to in the above quotation as supratemporal, but which it is now clear is the supramastoid. It is then homologous with the element in *Ichthyosaurus* and in the *Cotylosauria*, which I have called by that name. This discovery enables me to demonstrate the correctness of my supposition made in the paper already quoted (pp. 19-22), that the postero-lateral process of the parietal bone, so characteristic of *Sphenodon* and *Lacertilia*, really includes the supramastoid element. There is no question about the distinctness of this element from the parietal in the *Cimoliasaurus*, and the suture is shown in the outline figures given by Williston in his description referred to. The suture between it and the supratemporal is not so distinct, but is nevertheless visible. The following figure is copied from Williston, with the sutures inserted as I observed them.

*"On the Homologies of the Posterior Cranial Arches in the Reptilia," *Trans. Amer. Philos. Soc.*, 1892, p. 11.

†*L. c.*, p. 21.



Posterior part of right side of skull of *Cimoliasaurus snovii* Willist.
Modified after Williston.

I embrace the present opportunity to correct an error into which I inadvertently fell when naming the elements of the cranium in the *Cotylosauria*, in the essay above quoted. That segment which forms the lateral angle of the superior table of the skull in the *Cotylosaurian* reptiles, the *Stegocephalous* batrachians, and many fishes, is there termed the *os intercalare*, after Cuvier. It is, however, not his intercalare, but his external occipital. This is the *epiotic* of Huxley, but as it is not homologous with that element in the *Reptilia*, it requires another name. I propose that it be called the *os tabulare*, or the tabular bone. I do not know of any reptiles other than the *Cotylosauria* in which it is present; (see Pl. x, *Tab.*).

I refer in this connection to a taxonomic question which depends on a correct knowledge of the posterior part of the *Reptilian* skull. Huxley* referred the Triassic genus *Telerpeton* to the *Lacertilia*, and I afterwards† endeavored to show that this genus, together with *Rhynchosaurus*, *Hyperodapedon* and *Saurosternum* belong to the *Rhynchocephalia*. In this I have been followed by most authors who have since treated of the subject. After a study of the cranial arches, I became convinced that these genera could not be *Rhynchocephalia*,‡ since they possess but one postorbital bar, while the *Rhynchocephalia* possess two. In the papers cited below I placed them in the *Theromora* in the subdivision *Progano-sauria*, and associated with them the *Proterosauriidae*. It has become evident that this is their true position, and that they are not far removed from the *Anomodontia*, with which they were nearly contemporary in

* *Quarterly Journ.. Geolog. Society*, London, 1869, p. 49.

† *Proceeds. Amer. Assoc. Adv. Sci.*, 1870, Vol. xix, p. 241.

‡ "Synopsis of the Families of Vertebrata," *American Naturalist*, Oct., 1889. *Syllabus of Lectures on Vertebrata Univ. of Pennsylvania*, July, 1891, p. 38.

time. It is doubtful whether the family of the Mesosauridæ on which the Proganosaurian order was founded by Baur, really belongs to this series, while the genus *Procolophon* Owen probably does. This genus has been regarded as the type of a group, the *Procolophonina*, by Seeley, and the genus *Proterosaurus* has been made the type of another group by the same author, under the name of *Proterosauria*. I have shown that the postorbital bar of the *Pelycosauria* (? *Theriodonta*) is different from that of the *Anomodontia*, and that the *Cotylosauria* (*Pariasauria*) is entirely distinct as an order. The *Theromora* as an order will then include the suborders, *Placodonta*, *Proterosauria* and *Anomodontia*. The problematical genera above named will all fall within the limits of the *Proterosauria*, as I have defined it under the name of *Proganosauria*.

EMBAPHIAS CIRCULOSUS, gen. et sp. nov.

Char. gen. Cervical vertebræ short, with the parapophysis and diapophysis distinct at the base and articulating freely with the centrum. Articular faces of the centra concave in the cervical and dorsal regions. Suture of neural arch with centrum, persistent.

The limbs of this genus are not certainly known. The three vertebræ on which it is established were found associated with a considerable number of the vertebræ of *Elasmosaurus*, and a number of bones of the arches and extremities. The proper location of the latter has not yet been made.

This is a short-necked genus, and need not be compared especially with *Plesiosaurus*, *Elasmosaurus* and *Polycotylus*. It differs from *Uronautes*, *Orophosaurus* and *Trinacromerum* in the distinctness of the basal parts of the dia- and parapophyses, and from the first two in the strong concavity of the vertebral centra. It approaches nearest in its vertebral characters to *Pliosaurus*, but here the dorsal vertebræ are amphiplatyan as in *Plesiosaurus*. I note here that the vertebral characters of *Trinacromerum* Cragin, as described by him,* agree with those of *Orophosaurus*.†

Char. specif. Cervical centrum a regular transverse wide oval, without lateral longitudinal angulation. Dia- and parapophysial facets compressed so as to be vertical, and occupying a line from near the level of the inferior face to the base of the neural arch, and fused together at their bases. The bases of the dia- and parapophyses (which are lost) were thus vertically compressed, presenting a character different from that of any *Plesiosauroid* known to me. On other cervicals than the single one preserved, this character may not be so pronounced, but it is not likely to have been entirely wanting on any of them. The outlines of the dorsal vertebral centra are circular, and the slightly concave sides are without angulation. The fossa for the neurapophysis is an anteroposterior oval, which does not extend over the entire length of the centrum. Arches lost, except the bases, which adhere within the fossæ. An epiphysis-like band of vertically lined surface, narrows the median longitudinally lined surface of

* *American Geologist*, 1888, p. 404; 1891, p. 171.

† *American Naturalist*, 1887, p. 561.

the middle portion of the surface of the centrum, especially at the middle line below, where it is thickened. A large foramen on each side of the middle line below, and a large one below the parapophysis in the cervical, and below the neuropophysis in the dorsal centra. Some smaller ones on the sides of the dorsals. Surfaces of the centra smooth. Neural canal narrow.

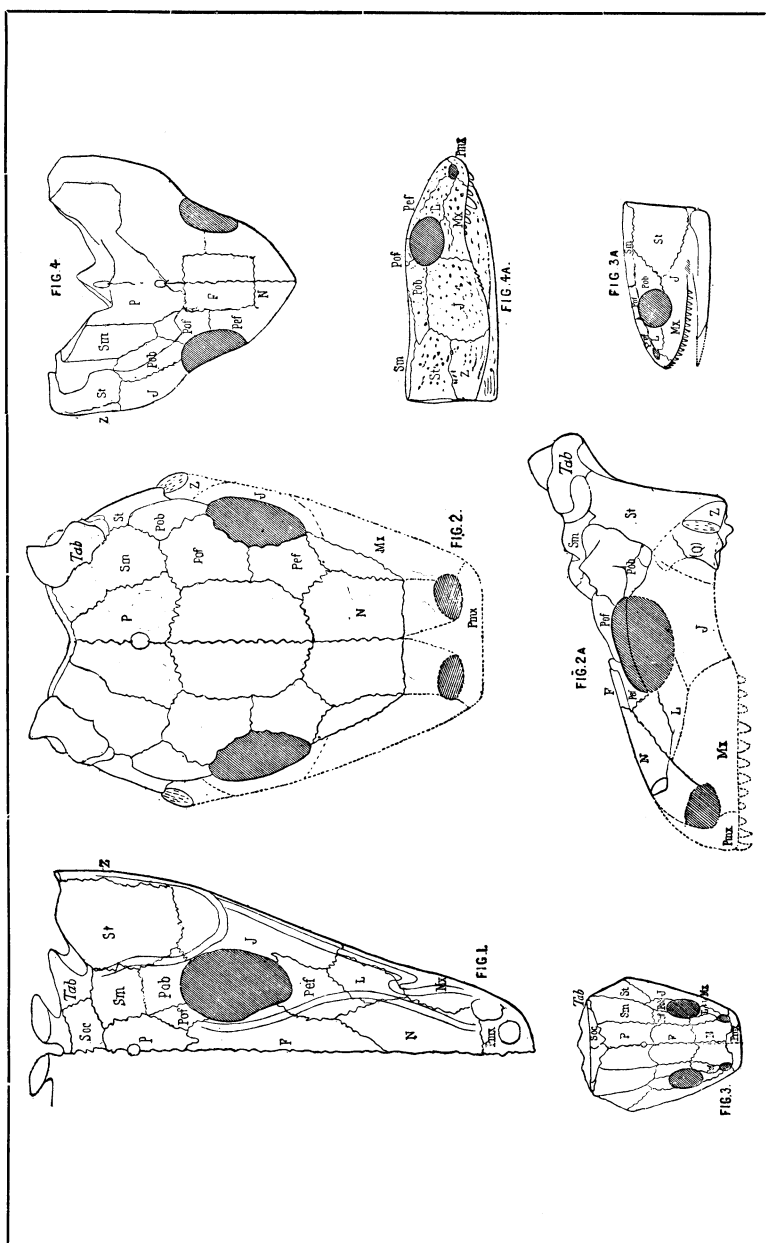
<i>Measurements.</i>		MM.
Diameters of cervical centrum {	anteroposterior.....	45
	transverse.....	85
	vertical.....	76
Vertical diameter of common base of dia- and parapophysis.		67
Diameters of base of parapophysis {	anteroposterior.....	17
	vertical.....	36
Diameters of a dorsal centrum {	anteroposterior.....	54
	transverse.....	99
	vertical.....	95
Width of neural canal at base.....		19
Depth of concavity of centrum.....		13

This is a species of large size, though not equal in dimensions to the known species of *Elasmosaurus*. It was found in the upper Cretaceous bed of the Pierre epoch, at the Big Bend of the Missouri river in South Dakota. It was presented to the Academy of Natural Sciences by Mr. John H. Charles, of Sioux City, together with the remains of *Elasmosaurus* below mentioned. I wish to express my sense of the obligation under which Mr. Charles has placed the Academy and myself by his liberality in this and other matters.

ELASMOSAURUS INTERMEDIUS, sp. nov.

Established on a series of nineteen vertebræ of the cervical and anterior dorsal regions of an individual from the Pierre formation of South Dakota.

The vertebral centra are the shortest known in the genus, approaching the *Cimoliasaurus* in proportions. The median and anterior cervicals display the compressed form characteristic of *Elasmosaurus*, although they are shorter than in the three known species of that genus. The posterior median cervical vertebræ are depressed, but the centra of the posterior members of that series are less depressed, and they increase in length less rapidly than they do in depth. They are shorter absolutely and relatively than in the *E. orientalis* Cope, to which this species is most nearly related. In the anterior dorsals the depth exceeds the length of the centrum, while in the *E. orientalis* the depth is about two-thirds the length. The cervicals exhibit an angle of the lateral surface about half way between the diapophysis and neuropophysis. The angle disappears on the anterior dorsals. The superior and inferior outlines of the articular faces are not emarginate or concave medially, which they are in the *E. orientalis*.



Stegocephali and Cotylosauria.

The lateral walls of the centra near to the articular faces are marked with strong rather sharp ridges, which are separated by grooves of several times their width.

	Measurements.	MM.
Diameters of an anterior cervical	anteroposterior	55
	transverse	44
	vertical	45
Diameters of a median cervical	anteroposterior	76
	transverse	70
	vertical	65
Diameters of a posterior cervical	anteroposterior	78
	transverse	107
	vertical	88
Diameters of an anterior dorsal	anteroposterior	74
	transverse	96
	vertical	90

The specimen was found with that of the *Embaphias circulosus* at the Big Bend of the Missouri in South Dakota, and was presented to the museum of the Academy of Natural Sciences by Mr. John H. Charles, of Sioux City, Ia.

ELASMOSAURUS sp.

Prof. N. H. Winchell sent me for examination a portion of the vertebral column of a Plesiosauroid from the Niobrara Cretaceous of Dakota (exact locality not known), which consists of forty-three centra and portions of the arches and limbs. It is one of the shorter-necked forms of the genus, resembling the *E. intermedius* in the proportions of its cervical vertebrae. The dorsals are relatively larger, but they are all, with most of the cervicals, so distorted by pressure that it is impossible to characterize the species.

EXPLANATION OF PLATE.

Permian and Triassic Cotylosauria and Stegocephali :

Fig. 1. *Mastodonsaurus giganteus* Jaeger ; $\frac{1}{3}$ nat. size ; from the Trias of Germany. From Fraas.

Fig. 2. *Chionyx rapidens* Cope ; $\frac{3}{4}$ nat. size ; from the Permian of Texas.

Fig. 3. *Pariotichus megalops* Cope ; nearly nat. size ; from the Permian of Texas.

Fig. 4. *Pantylus cordatus* Cope ; nearly half nat. size ; from the Permian of Texas.

Lettering.

Tab., Ostabulare ; *Soc.*, Supraoccipital ; *Sm.*, Supramastoid ; *St.*, Supratemporal ; *Z.*, Zygomatic (quadratojugal) ; *Pob.*, Postorbital ; *Pof.*, Postfrontal ; *P.*, Parietal ; *F.*, Frontal ; *Pef.*, Prefrontal ; *J.*, Jugal ; *Q.*, Quadrate ; *L.*, Lachrymal ; *Mx.*, Maxillary ; *N.*, Nasal ; *Pmx.*, Premaxillary.